Syllabus for Math 1552 "Calculus II"

Text: Calculus Early Transcendentals (2008) by Jon Rogawski

This is a four hour Calculus course primarily designed for engineering majors and certain other technical majors. As mentioned above, the text is Calculus: Early Transcendentals (2008) by Jon Rogawski. The student is assumed to be capable and versed in the standard Calculus I topics of taking limits, continuity, taking derivatives of fairly complicated functions, using derivatives, calculating the definite integral for basic functions, integration by substitution and the standard applications of the definite integral. The beginning instructor should be aware that some students with weaker Calculus I backgrounds may need to review math 1550 rather extensively. In particular, the chain rule, the basic integral formulas and integration by substitution should be reviewed by students not fully prepared for the course. In a similar vein, some students will need to review trigonometric equations and polar coordinates. Since this is a four hour class, the student should expect at least three exams and a final exam. This is a suggestion and not a fiat. No departmental policy is in place regarding the use of sophisticated calulators in the classroom and the instructor must make the decision about technology on their own. A set of WebWork problems has been established and is available for interested faculty. I am available to discuss the course with you. If you have questions please drop by my office to chat.

(Paul Britt)

Basic skills the students should acquire during the course

1. Techniques of Integration
   a. Approximate integrals using numerical integration
   b. Evaluate integrals using substitution
   c. Evaluate integrals using integration by parts
   d. Evaluate integrals of trigonometric forms
   e. Evaluate integrals by trigonometric substitution
   f. Evaulate integrals by the method of partial fractions

2. Infinite Series
   a. Analysis of sequences and their convergence
   b. Use the definition of convergence for series
   c. Use the integral test, the comparison tests, the ratio test and the root test
   d. Determine power series and their intervals of convergence
   e. Form Taylor series for common functions and master simple applications of Taylor series

3. Parametric Equations, Polar Coordinates and Conic Sections

   a. Draw parametric curves and calculate derivatives along parametric curves
   b. Calculate arc length and speed along parametric curves
   c. Draw polar curves and convert between rectangular and polar forms
   d. Calculate arc length and areas using polar coordinates
   e. Sketch conic sections and write the equations of conic sections

4. Vectors
   a. Be able to draw two dimensional vectors and do simple arithmetic on vectors
   b. Be versant with three space and three space vectors
   c. Be able to calculate dot products, the angle between vectors and vector projections
   d. Calculate cross products and know the geometric interpretations of cross products
   e. Be able to write equations of planes meeting the usual conditions

5. Calculus of Vector Valued Functions
   a. Recognize and sketch simple vector valued functions
   b. Compute limits and derivatives of vector valued functions
   c. Calculate arc length and speed for vector valued functions
   d. Calculate curvature, the unit normal and the osculating circle for simple parameterizations
   e. Be versant with uniform circular motion and ballistics motion

6. Partial Derivatives
   a. Be able to compute partial derviatives of simple functions
   b. Understand Clairault's Theorem

A specific section by section syllabus and comments are shown below. A recommended set of homework problems is not provided. The textbook has a wide range of problems, from drill level through conceptual analysis. The instructor is urged to assign a broad range of problems from each section. Do not merely assign drill problems. The non-routine, challenging problems should form some part of each homework assignment.

Syllabus

Chapter 7

Section 7.1

Numerical Integration: The author motivates the trapezoidal rule as an average of the left and right hand sums and motivates Simpson's Rule as a weighted average of the trapezoidal rule and the midpoint rule. The instructor should stress the reason for studying numerical approximations. Too many students think all problems admit closed form solutions.

Section 7.2

Integration by parts: The presentation is fairly standard. Integration by parts is needed in later coursework. The instructor should be prepared for their students having difficulty with the idea of substitution. Some experienced instructors review the differentiation formulas and integration by substitution on the first day.

Section 7.3

Trigonometric Integrals: The trigonometric forms are needed to do trigonometric

substitutions in the next section. The material is fairly standard

Section 7.4

Trigonometric Substitutions: The students have a great deal of trouble deciding which trig substitution to use. The instructor is urged to pay particular attention to explaining how to decide which substitution is appropriate and why. The author's summary is pretty good in helping with this.

Section 7.5

(OPTIONAL)Integrals of Hyperbolic and Inverse Hyperbolic Functions: Please be advised this material is treated as optional in Math 1550. Some of your students will not have heard of these functions. If you choose to cover this topic you may need to provide the necessary background from Math 1550.

Section 7.6

Partial Fraction Decomposition: This material is used in the differential equations course. The instructor does not have to assign horribly comlicated decompositions but the case with irreducible quadratic denominators should be covered. That case will show up when the students are computing inverse Laplace Transforms in D.E.

Section 7.7

Improper Integrals: This is a fairly standard topic. The instructor should carefully discuss the comparison tests, because that will set the stage for the use of comparisons in the infinite series chapter.

Chapter 10

Section 10.1

Sequences: The students have a hard time identifying a sequence as a function with a restricted domain. Thus, they do not see the limit of a sequence as the horizontal asymptote of a function. Since this is the chapter on series, the cornerstone of everyone's second calculus course, the instructor might want to spend more time on this chapter than on other chapters. It is my experience that students need to proceed slowly through the material on series.

Section 10.2

Summing an Infinite Series: This section includes the definition of convergence for series. The students have enormous difficulty with the Divergence Test. The students need to be aware that the terms of a series tending to zero is not sufficient to insure convergence. The geometric series and the telescoping series make their appearance in this chapter.

Section 10.3

Positive Term Series: The section includes the integral test and the two comparison tests. The instructor should provide numerous examples of using the comparison test. The students need to know how you choose the series you are using for coomparison.

Section 10.4

Absolute and Conditional convergence: This is a standard presentation. The students need to be made aware that absolute convergence implies convergence. The students have a tendency to use the Alternating Series Test on series which

do not alternate. They will also claim a series is conditionally convergent without ever testing for absolute convergence.

Section 10.5

The Ratio and Root Tests: The Ratio Test is the more useful of the two tests in this section. The students will need an introduction to the notion of factorials.

Section 10.6

Power Series: This section introduces the idea of the interval of convergence for a power series and constructs power series based on the geometric series. Term-by-term differentiation and integration of series also appear and are used to generate the familiar series for the logarithm and the arctangent. The material on series solutions to differential equations should not be covered.

Section 8.4

Taylor Polynomials: It is somewhat unfortunate that the material on Tayor Polynomials is not located in chapter 10. The material on polynomial approximation is an important introduction to the Taylor Series material in the next section. The instructor should spend the time to go back to chapter 8 and teach this section

Section 10.7

Taylor Series: This section includes the binomial series, which may be considered optional. The construction of Taylor Series from known series is very useful. The summary section at the end of the sectioin is particularly useful.

Chapter 11

Section 11.1

Parametric Equations: The students have usually not seen parametric equations before this chapter. The students benefit from simple examples showing elimination of a parameter. When taking derivatives of parametric curves, the students should not confuse dx/dt, dy/dt and dy/dx.

Section 11.2

Arc Length and Speed: This is a standard presentation. Please be aware that the integrals in this section can be challenging. Arc length and surface area of revolution integrals can easily become non-elementary nightmares. Asking students to set-up the integrals is a common solution to this issue.

Section 11.3

Polar Coordinates: This section is a useful re-introduction to polar coordinates. This is NOT optional. The students will not have seen polar coordinates in a while. Further, most students get a very superficial treatment in the lower courses. They benefit from going over a section like this. The instructor is warned that the author does not mention the derivative in polar coordinates in the body of the text. The derivative is covered in problem 51. The instructor is urged to devote some classtime to this topic.

Section 11.4

Arc Length and Area in Polar Coordinates: The students have difficulty in this section because they cannot identify the required regions. The limits of integration, frequently gotten by solving trig equations, are a perennial trouble spot.

Section 11.5

Conic Sections: This is a common topic and the presentation is unremarkable. The reflective properties of conics are fairly interesting and provide an example of conics used in real world settings.

Chapter 12

Section 12.1

Vectors in the Plane: Many instructors cover this chapter after the material on techniques of integration. The reasoning is that students in physics would benefit from seeing vectors early. This chapter is fairly straight-forward and most students do well with the material.

Section 12.2

Vectors in Three Dimensions: This section introduces three dimensional Cartesian coordiantes, three space vectors, spheres and the parametric equations of lines. Please stress parametric equations of lines, since they are useful in later courses.

Section 12.3

Dot Products: A standard presentation. Stress the uses of the dot product in calculating angles and projections.

Section 12.4

The Cross Product: The author uses the determinant to define the cross product. He proves the geometric aspects of the cross product. The volume of the rectangular parellelepiped can be calculated as the magnitude of the scalar triple product.

Section 12.5

Planes in Three-Space: The topic is standard and is normally not a problem for the students.

Section 12.6

Quadric Surfaces: This topic is mainly presented for the benefit of those students who will be going to Math 2057. The students do not normally draw very well. The instructor is encouraged to try to draw the figures carefully. The students will need to be able to draw figures well enough for them to use those figures in integral applications in Math 2057.

Section 12.7

(OPTIONAL)Cylindrical and Spherical Coordinates: While this is a useful topic, it is listed as optional. This is because everyone teaching Math 2057 has to teach this material again anyway. Students simply never remember these topics.

Chapter 13

Section 13.1

Vector Valued Functions: Students have problems with imagining three-space curves. The materail on parameterizing the intersection of surfaces is useful in Math 2057. The instuctor is encouraged to try to sketch numerous examples.

Section 13.2

Calculus of Vector Valued Functions: This simple sectioin includes limits, derivatives and integrals of vector valued functions.

Section 13.3

Arc Length and Speed: The arc length integral is familiar to the students. The idea of parameterizing a curve using arc length is difficult for most students.

Section 13.4

Curvature: The text introduces the various formulas for curvature and the students should be made familiar with all of them. The Unit Normal, the center of curvature and the osculating circle appear in this section.

Section 13.5

Motion in Three-Space: The text introduces uniform circular motion and ballistic motion. The instructor can treat the decomposition of acceleration into the normal and tangential vectors as an optional topic.

Chapter 14

Section 14.3

Partial Derivatives: The instructor should present this topic for the benefit of those students moving to Math 2090. The material can be taught from a mechanical standpoint.

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